COURSE STRUCTURE OF M.TECH (POWER SYSTEM CONTROLL & AUTOMATION)

I SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1	V18PST01	Power System Operation & Control	3	-	-	3
2	V18PST02	Advanced Computer Methods in Power Systems	3	-	-	3
3	V18PST03	Advanced Power System Protection	3	-	-	3
4	V18PST04	Micro Controllers and Application	3	-	-	3
5	V18PST05 V18PST06 V18PST07 V18PST08	Elective – I: 1. Power System Reliability 2. Application of AI Techniques in Power Systems 3. Electrical Distribution Systems 4. Power System Security	3	-	-	3
6	V18PST09 V18PST10 V18PST11 V18PST12	Elective – II: 1. Reactive Power Compensation & Management 2. Power Quality 3. Power System Transients 4. Voltage Stability	3	-	-	3
7	V18PSL01	Power Systems Lab-I	-	-	4	2
8	V18PST41	Seminar-I	-	2	-	2
Total Contact Hours: 24			Total Credits: 22			

II SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1	V18PST13	Modern Control Theory	3	-	-	3
2	V18PST14	Power System Dynamics & Stability	3	-	-	3
3	V18PST15	Solar & Wind Energy	3	-	-	3
4	V18PST16	Real Time Control of Power Systems	3	-	-	3
5	V18PST17 V18PST18 V18PST19 V18PST20	Elective – III: 1. Electrical and Hybrid Vehicles 2. Power System Deregulation 3. Smart Grid 4. High Voltage Engineering	3	-	-	3
6	V18PST21 V18PST22 V18PST23 V18PST24	Elective – IV: 1. Custom Power Devices 2. EHVAC Transmission 3. Demand Side Energy Management 4. HVDC & FACTS	3	-	-	3
7	V18PSL02	Power Systems Lab-II	-	-	4	2
8	V18PST42	Seminar-II	-	2	-	2
Total Contact Hours: 24			Total Credits: 22			

MNC- Mandatory Non-Credit

III SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1	V18PST43	MOOCs	-	-	-	MNC
2	V18PST44	Comprehensive Viva-Voce	-	-	-	2
3	V18PSL05	Project Work	-	-	-	-
Total Credits: 2						

IV SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1	V18PSL05	Project Work Part (Continued)	-	-	-	24
Total Credits: 24						

SYLLABUS FOR M.TECH (POWER SYSTEM CONTROL & AUTOMATION)

I M.TECH-I SEMESTER

Course Code : V18PST01

POWER SYSTEM OPERATION AND CONTROL

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Unit commitment: Introduction, Simple & numeration, Constraints in UCP, UC solutions. Methods-priority list method, Dynamic programming Approach.

UNIT-II

Single area Load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response, load frequency control, Role of AGC. State spare model of an isolated system, pole placement design, optimal control design.

UNIT-III

Two area Load Frequency Control, uncontrolled case and controlled case, tie-line bias control. Optimal two-area LF control-steady state representation, performance Index and optimal parameter adjustment. State space model for a two are system

UNIT-IV

Generation with limited Energy supply, Take-or-pay fuel supply contract, and composite generation production cost function. Solution by gradient search techniques, hard limits and slack variables, Fuel scheduling by linear programming.

UNIT-V

Interchange Evaluation and Power Pools Economy Interchange, Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange contracts. After the-fact production costing, Transmission Losses in transaction Evaluation, other types of Interchange, power pools.

Text Books

1. I.J.Nagrath&D.P.Kothari, “Modern Power System Analysis” Tata McGraw-Hill Publishing Company ltd, 2nd edition.
2. PSR Murthy, “Power system operation and control”,B.S publication.
3. A.J.Wood&B.F.Wollenberg, “Power Generation, Operation and Control”, Johnwiley& sons Inc. 1984.

Reference Books

1. O.I.Elgerd, “Electrical Energy Systems Theory”, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
2. TJE Miller, “Reactive Power Control in Electric Systems”, John Wiley & sons.

I M.TECH-I SEMESTER

Course Code : V18PST02

ADVANCED COMPUTER METHODS IN POWER SYSTEMS

[L : 3; T: 0; P: 0 (3 credits)]

UNIT-I

Network modeling – Single phase and three phase modeling of alternators, transformers and transmission lines, Conditioning of Y Matrix –- Incidence matrix method, Method of successive elimination, Triangular factorization

UNIT-II

Load low analysis - Newton Raphson method, Fast Decoupled method, AC-DC load flow **–** Single and three phase methods **–** Sequential solution techniques and extension to multiple and multi-terminal DC systems.

UNIT-III

Fault Studies -Analysis of balanced and unbalanced three phase faults **–** fault calculations **–** Short circuit faults **–** open circuit faults

UNIT-IV

System optimization - strategy for two generator systems **–** generalized strategies **–** effect of transmission losses - Sensitivity of the objective function - Formulation of optimal power flow-solution by Gradient method-Newton's method

UNIT-V

State Estimation – method of least squares **–** statistics **–** errors **–** estimates **–** test for bad data **–** structure and formation of Hessian matrix **–** power system state estimation

Test Books:

1. Grainger, J.J. and Stevenson, W.D. "Power System Analysis" Tata McGraw hill, New Delhi, 2003.
2. G W Stagg and A H El Abiad, "Computer Methods in Power System Analysis", McGraw Hill, 1968
3. Pai, M.A., "Computer Techniques in Power System Analysis", Tata McGraw Hill, New Delhi, 2006.

References:

1. HadiSaadat, "Power System Analysis", Tata McGraw hill, New Delhi, 2002.
2. Arrillaga, J and Arnold, C.P., "Computer analysis of power systems" John Wiley and Sons, New York, 1997.

I M.TECH-I SEMESTER

Course Code : V18PST03

ADVANCED POWER SYSTEM PROTECTION

[L: 3; T: 0; P : 0 (3 credits)]

UNIT-I

Static Relays: Advantages of static relays-Basic construction of static relays-Level detectors-Replica impedance –Mixing circuits-General equation for two input phase and amplitude comparators-Duality between amplitude and phase comparators.

Amplitude Comparators: Circulating current type and opposed voltage type- rectifier bridge comparators, Direct and Instantaneous comparators, Static Over Current Relays**,**Differential Relays

UNIT-II

Static Distance Relays: Static impedance-reactance**–**MHO and angle impedance relay-sampling comparator **–**realization of reactance and MHO relay using sampling comparator.

Phase Comparators: Coincidence circuit type- block spike phase comparator, techniques to measure the period of coincidence-Integrating type-Rectifier and Vector product type- Phase comparators.

UNIT-III

Multi-Input Comparators: Conic section characteristics-Three input amplitude comparator **–**Hybrid comparator-switched distance schemes **–**Poly phase distance schemes- phase fault scheme **–**three phase scheme **–** combined and ground fault scheme. POWER SWINGS: Effect of power swings on the performance of distance relays **–**Power swing analysis-Principle of out of step tripping and blocking relays-effect of line and length and source impedance on distance relays.

UNIT-IV

Microprocessor Based Protective Relays (Block diagram and flowchart approach only)

Over current relays**–**impedance relays-directional relay-reactance relay .Generalized mathematical expressions for distance relays-measurement of resistance and reactance **–**MHO and offset MHO relays-Realization of MHO characteristics-Realization of offset MHO characteristics -Basic principle of Digital computer relaying.

UNIT-V

Digital Protection: Application of wavelet protection to power system protection- transmission line protection, transformer protection, synchronous generator protection. Numerical differential protection of generator and transformers.

Text Books

1. Badri Ram and D.N.Vishwakarma, “Power system protection and Switch gear”, TMH publication New Delhi 1995.
2. T.S. MadhavaRao, “Power system protection Static relays”, TMH 2nd edition 1981

Reference Books

1. Mason, “The Art and Science of protective relaying”, Wiley Eastern Ltd
2. C.L. Wadhwa, “Electrical power systems”, New Age International (P) Limited
3. Sunil S. Rao, “Switchgear and protection”, Khanna Publications

I M.TECH-I SEMESTER

Course Code : V18PST04

MICRO CONTROLLERS AND APPLICATIONS

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

INTRODUCTION TO MICROCONTROLLERS

Overview of 8 bit and 16 bit Microcontrollers, CISC & RISC Processors, Harvard & Von-Neumann architectures, features of 8051 Micro Controller, PIN diagram, architecture, Memory organization, Different modes of operation of timer/counters.

UNIT II

PROGRAMMING OF 8051

Instruction set, Addressing modes, sample programs, introduction to embedded C, simple programs, development tools.

UNIT III

REAL TIME CONTROL: INTERRUPTS

Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – Non-maskable interrupt sources – Enabling or Disabling of the sources – Polling to determine the Interrupt source and assignment of the priorities among them –Interrupt structure in Intel 8051.

UNIT IV

INTERFACING

LEDs & switches interfacing, keypad interfacing, Seven Segment Display interfacing, ADC & DAC interfacing, 2X16 LCD interfacing, stepper motor interfacing, serial port interfacing, high power devices, simple calculator development.

MICROCONTROLLER BASED INDUSTRIAL APPLICATIONS

Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments

UNIT V

PIC MICROCONTROLLERS

Overview and features, architecture of PIC 16C6X/7X, PIC memory organization, PIC 16C6X/7X instructions, addressing modes, I/O ports, Interrupts in PIC 16C61/71, PIC 16C61/71 timers.

UNIT VI

ARM 32 Bit MCUs:

Introduction to 16/32 Bit processors–ARMarchitecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set.

Text Books

1. Kenneth J Ayala, "The 8051Microcontrollers: Architecture, Programming & Applications", Second Edition, Penram International Publishing (India).
2. A.V. Deshmukh, "Microcontrollers (Theory & Applications)", 6th Reprint, TMH, 2007.

Reference Books

1. Raj Kamal, "Microcontrollers Architecture, Programming, Interfacing and System Design", 2nd Edition, Pearson Education, 2005.
2. Mazidi and Mazidi, "The 8051 Microcontroller and Embedded Systems", 4th impression, PHI, 2000.

I M.TECH-I SEMESTER

Course Code : V18PST05

POWER SYSTEM RELIABILITY (ELECTIVE – I)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Basic probability theory – rules for combining probabilities of events – Bernoulli's trials – probability density and distribution functions – binomial- distributions – expected value and standard deviation ofbinomial distribution.

UNIT -II

Network Modelling and Reliability Analysis of Series, Parallel, Series- Parallel networks – complex networks – decomposition method Reliability functions f(t), F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponential distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF.

UNIT –III

Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabilities using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycletime, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states.

UNIT-IV

Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

UNIT-V

Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

Text Books

1. R.Billinton, R.N.Allan, "Reliability Evaluation of Engineering System", Plenum Press, New York.
2. R.Billinton, R.N.Allam, "Reliability Evaluation of Power System", Plenum Press, New York
3. Sharies E Ebeling, "An Introduction to Reliability and Maintainability Engineering", TATA McGraw Hill – Edition

Reference Books

1. J. Endrenyi, "Reliabilitymodelling in electric power system", John wiley and sons publications
2. Syed Ali, "Digital switching systems" system reliability and analysis", McGraw-Hill ,1997.

I M.TECH-I SEMESTER

Course Code : V18PST06

APPLICATION OF AI TECHNIQUES IN POWER SYSTEMS (ELECTIVE – I)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Arti icial Neural Networks:

Introduction Models of Neuron Network – Architectures – Knowledge representation – Artificial Intelligence and Neural networks–Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzman learning –Supervised learning – Unsupervised learning – Reinforcement learning – learning tasks.

UNIT-II

ANN Paradigms:

Multi – layer perceptron using Back propagation Algorithm (BPA) – Self – Organizing Map (SOM) – Radial Basis Function Network – Functional Link Network (FLN) – Hopfield Network.

UNIT-III

Fuzzy Logic:

Introduction – Fuzzy versus crisp – Fuzzy sets – Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy Cartesian Product – operations on Fuzzy relations – Fuzzy-logic – Fuzzy Quantifiers–Fuzzy Inference – Fuzzy Rule based system–Defuzzification methods.

UNIT-IV

Genetic Algorithms:

Introduction–Encoding – Fitness Function–Reproduction operators–Genetic Modeling – Genetic operators–Cross over – Single site cross over – Two point cross over – Multi point cross over – Uniform cross over – Matrix cross over–Cross over Rate –Inversion & Deletion – Mutation operator–Mutation – Mutation Rate–Bit–wise operators –Generational cycle – convergence of Genetic Algorithm.

UNIT-V

Applications of AI Techniques:

Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system – Small Signal Stability (Dynamic stability) Reactive power control – speed control of DC and AC Motors.

Text books:

1. S.Rajasekaran and G.A.V.Pai,"Neural Networks, Fuzzy Logic & Genetic Algorithms", PHI, New Delhi, 2003.
2. Rober J. Schalkoff, "Artificial Neural Networks", Tata McGraw Hill Edition, 2011

Reference Books:

1. S. Rajasekaran and G.A.V. Pai"Neural Networks, Fuzzy Systems And Evolutionary Algorithms : Synthesis And Applications",PHI, New Delhi

I M.TECH-I SEMESTER

Course Code : V18PST07

ELECTRICAL DISTRIBUTION SYSTEMS (ELECTIVE – I)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT- I

General : Introduction to Distribution systems, an overview of the role of computers in distribution system planning-Load modeling and characteristics: definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT-II

Distribution Feeders and Substations

Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder-loading. Design practice of the secondary distribution system.

Location of Substations: Rating of a Distribution Substation, service area with primary feeders. Benefits derived through optimal location of substations. Distributed Generation placement and modelling.

UNIT -III

System Analysis: Voltage drop and power loss calculations - Derivation for volt-drop and power loss in lines, manual methods of solution for radial networks, three-phase balanced primary lines, non-three-phase primary lines.

UNIT- IV

Protective devices and coordination: Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices General coordination procedure.

UNIT -V

Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and Switched) power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location. Voltage Control - Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

Text Books:

1. TuranGonen, “Electric Power Distribution System Engineering”,Mc.Graw-Hill Book Company,1986.
2. A.S.Pabla “Electric Power Distribution”, Tata McGraw-Hill Publishing Company, 4th edition, 1997.

Reference Books:

1. V.Kamaraju, “Electrical Distribution”, McGraw Hill
2. Gorti Ramamurthy, “Handbook of Electrical Power Distribution”, Universities press.

I M.TECH-I SEMESTER

Course Code : V18PST08

POWER SYSTEM SECURITY (ELECTIVE – I)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Short circuit analysis techniques in AC power Systems- Simulation of short circuit and open circuit faults using network theorems- fixed impedance short circuit analysis techniques-time domain short circuit analysis in large scale power systems- analysis of time variation of AC and DC short circuit components.

UNIT-II

Fixed impedance Short circuit analysis of large scale power systems general analysis of balanced, unbalanced and open circuit faults- 3- phase short circuit analysis in large scale power systems, Network equivalents and practical short circuit current assessments in large scale Ac power systems - uncertainties in short circuit current calculations.

UNIT-III

Risk assessment and safety considerations-control and limitation of high short circuit currents-limitation of short circuit currents in power system operation, Types of short circuit fault current limiters and their applications.

UNIT-IV

Power System Security analysis- concept of security- security analysis and monitoring- factors affecting power system security- detection of network problems, contingency analysis for generator and line outages by ILPF method – fast decoupled inverse Lemma-based approach, network sensitivity factors.

UNIT-V

Computer control power systems – need for real time and computer control of power systems-operating states of power system – SCADA implementation considerations – software requirements for implementing above functions.

Reference Books

1. Allen J. Wood and Bruce Woolenberg, "Power System Generation,Operation and Control", 1st edition, John Willey and sons,1996.
2. John J.Grainger and William D Stevenson Jr.,"Power System, analysis",McGraw Hill,ISE,1994.

Text Books

1. 1.NasserD.Tleis, "Power System Modelling and fault analysis", Elsevier, 2008.
2. P.Venkatesh, B.V.Manikandan, S.Charles Raja, A.Srinivasan, "Electrical Power Systems, Analysis, Security and Deregulation", kindle edition, PHI publication.

I M.TECH-I SEMESTER

Course Code : V18PST09

REACTIVE POWER COMPENSATION & MANAGEMENT (ELECTIVE – II)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Load Compensation Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

UNIT- II

Reactive power compensation in transmission system: Steady state - Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

UNIT-III

Reactive power coordination: Objective – Mathematical modelling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and
Electromagnetic interferences

UNIT-IV

Distribution side Reactive power Management: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks User side reactive power management: KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

UNIT-V

Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedialmeasures –power factor of an arc furnace

Text Books/ Reference Books

1. T.J.E.Miller, “Reactive power control in Electric power systems”, John Wiley and sons, 1982
2. D.M.Tagare, “Reactive power Management”, Tata McGraw Hill
3. W.Hofmann, J.Schlabbach, W. Just “Reactive power compensation, a practical guide”, John Wiley and sons

I M.TECH-I SEMESTER

Course Code : V18PST10

POWER QUALITY (ELECTIVE – II)

[L: 3; T:0; P: 0 (3 credits)]

UNIT-I: Introduction

Overview of Power Quality - Concern about the Power Quality - General Classes of PowerQuality Problems – Transients -Long-Duration Voltage Variations - Short-Duration VoltageVariations - Voltage Unbalance - Waveform Distortion - Voltage fluctuation - Power FrequencyVariations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags andInterruptions – Nonlinear loads.

UNIT-II: Transient Over Voltages

Source of Transient over Voltages - Principles of Over Voltage Protection - Devices for OverVoltage Protection - Utility Capacitor Switching Transients - Utility Lightning Protection – LoadSwitching Transient Problems - Computer Tools for Transient Analysis

UNIT-III: Harmonic Distortion and solutions

Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities underNonsinusoidal Conditions - Harmonic Indices – Sources of harmonics - Locating Sources ofHarmonics – System Response Characteristics - Effects of Harmonic Distortion – Interharmonics-Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling HarmonicDistortion - Harmonic Filter Design - Standards on Harmonics

UNIT- IV: Long Duration Voltage Variations

Principles of Regulating the Voltage - Device for Voltage Regulation - Utility Voltage RegulatorApplication - Capacitor for Voltage Regulation - End-user Capacitor Application – RegulatingUtility Voltage with Distributed Resources – Flicker

UNIT-V: Distributed Generation and Power Quality

Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System -Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks -Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems -Solution to Wiring and grounding Problems

Text Books:

1. Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, "Electrical Power Systems Quality", Second Edition, McGraw-Hill, 2002.
2. Kennedy B.W., "Power Quality Primer", First Edition, McGraw-Hill, 2000.
3. W.E. Kazibwe and M.H. Sendula, "Electric power quality control techniques", Springer.

Reference Books:

1. C. Shankaran, "Power Quality", CRC Press, 2001
2. Franciso C.DE LA Rosa, "Harmonics and Power Systems", CRC Press.
3. Ewald F. Fuchs, Mohammad A.S. Masoum, "Power Quality in Power Systems& Electrical Machines", Academic Press.

I M.TECH-I SEMESTER

Course Code : V18PST11

POWER SYSTEM TRANSIENTS (ELECTIVE – II)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Basic Concepts and Simple Switching Transients: Switching an RL,RC,RLC circuits

Transients Analysis of Three-Phase power Systems: Symmetrical components in Three-phase Systems, Sequence Components for Unbalanced Network Impedances, the Sequence Networks, analysis of Unsymmetrical Three-Phase Faults-single line-to-Ground Fault, Three phase-to-ground fault.

UNIT -II

Travelling Waves: Velocity of Travelling waves and Characteristic Impedance, Energy Contents of Travelling Waves, Attenuation and Distortion of Electromagnetic Waves, telegraph equations-lossless line, distortion less line, Reflection and Refraction of Travelling Waves, Reflection of Travelling Waves against Transformer-and-Generator windings, the Origin Transient Recovery voltages, bewley-lattice diagram. travelling waves and multi conductor system.

UNIT-III

Switching Transients: Arc interruption in circuit breaker, transient recovery voltage, arc-circuit interaction, interruption of capacitive currents, interruption of inverse currents, interruption of fault current in transmission line and transformers.

UNIT-IV

Power System Transient Recovery Voltages: Characteristics of the Transient Voltage- Short-circuit test duties based on IEC 60056 (1987),ANSI/IEEE Standards, the Harmonization between IEC and ANSI/ IEEE Standards with respect to Short-circuit Test duties, transient recovery voltage for Different types of faults.

UNIT-V

Lightning –Induced Transients: Mechanism of Lightning, wave shape of the lightning current, direct lighting Stroke to transmission line towers, direct lightening stroke to a line, lightning protection scheme. Numerical simulation of electrical transients, The Electromagnetic Transient Program, principles of numerical techniques used in transient simulation.

Text Books

1. Allen Greenwood, "Electrical Transients in Power System", McGraw Hill 1990
2. A.P.SakisMeliopolous, "Power System Grounding and Transients: An Introduction", Marcel Dekker, INC.
3. Lou Van Sluis, "Transients in power systems", Wiley.

Reference Books

1. A.Ametani – "Power system transients theory and applications" CRC publications.
2. C.S. Indulkar, D.P. Kothari, K. Ramalingam, "Power system transients", PHI publications.

I M.TECH-I SEMESTER

Course Code : V18PST12

VOLTAGE STABILITY (ELECTIVE – II)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Reactive Power flow and voltage stability in power systems: Physical relationship indicating dependency of voltage on reactive power flow - reactive power, transient stability; Q-V curve; definition of voltage stability, voltage collapse and voltage security. Voltage collapse phenomenon, Factors of voltage collapse, effects of voltage collapse, voltage collapse analysis.

UNIT-II

Power system loads: Load characteristics that influence voltage stability such as – Discharge lighting, Induction motor, Air conditioning and heat pumps, Electronic power supplies, Over Headlines and cables.

UNIT-III

Reactive Power compensation: Generation and absorption of reactive power – Reactive power compensators & voltage controllers: - shunt capacitors, synchronous phase modifier – static VAR system – on load tap changing transformer, booster transformers.

UNIT-IV

Voltage stability static indices : Development of voltage collapse index – power flow studies – singular value decomposition – minimum singular value of voltage collapse – condition number as voltage collapse index.

UNIT-V

Voltage stability margins & Improvement of voltage stability: Stability margins, voltage stability margin of uncompensated and compensated power system. Dynamic voltage stability – voltage security, Methods of improving voltage stability and its practical aspects.

Text Books

1. Chakrabarti, D.P.Kothari, A.K. Mukhopadhyay, "Performance operation and control of EHV power transmission Systems", A H Wheeler Publishing Co Ltd
2. C.W. Taylor, "Power System Voltage Stability", Mc. Graw Hill, 1994

Reference Books

1. Francis T.S. Yu, "Electric power system dynamics", Academic Press
2. PrabhaKundur, "Power system stability & control" , Mc. Graw Hill Education.
3. K.R. Padiyar"Power system Dynamics, stability & control", BS publications.

I M.TECH-I SEMESTER

Course Code : V18PSL01

POWER SYSTEMS LAB-I

[L: 0; T: 0; P: 4 (2 credits)]

Any 10 of the following experiments are to be conducted

1. Formation of Y- Bus by Direct-Inspection Method.
2. Load Flow Solution Using Gauss-Siedel Method
3. Load Flow Solution Using Newton Raphson Method
4. Formation of Z-Bus by Z-bus building algorithm
5. Unsymmetrical Fault analysis using Z-bus
6. Economic Load Dispatch with transmission losses
7. Economic Load Dispatch without transmission losses
8. Transient Stability Analysis Using Point By Point Method
9. Load Frequency Control of Single Area Control& with andwithout controllers.
10. Load Frequency Control of Two AreaControlsystem with andwithout controllers
11. Load Flow Solution Using Fast De-coupled Method.
12. Symmetrical Fault analysis using Z-bus

I M.TECH-II SEMESTER

Course Code : V18PST13

MODERN CONTROL THEORY

[L: 3; T: 0; P: 0 (3 credits)]

UNIT –I

State Variable Analysis: The concept of state – State Equations for Dynamic systems – State diagram---- Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions toContinuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

UNIT – II

State Variable Techniques: General concept of Controllability – General concept of Observability Controllability tests for Continuous &Time Invariant systems - Observability tests for Continuous &Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment.

UNIT – III

Non Linear Systems – 1: Introduction – Non Linear Systems – Types of Non – Linarites – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc. - Singular Points – Introduction to Linearization ofnonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions.

UNIT – IV

Non Linear Systems – 11: Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

UNIT – V

Stability Analysis Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunovsecondmethod – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

Text Books

1. M. Gopal, "Modern Control System Theory", New Age International – 1984
2. Ogata. K, "Modern Control Engineering", Prentice Hall – 1997

Reference Books

1. Hassan K. Klalil, "Nonlinear systems", Prentice Hall, 1996
2. Richard C. Dorf and Robert H. Bishop, "Modern control systems", 11th Edition, Pearson Edu, India, 2009

I M.TECH-II SEMESTER

Course Code : V18PST14

POWER SYSTEM DYNAMICS AND STABILITY

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I: System Dynamics

Synchronous machine model in state space: Synchronous Machine: Basic equations of a synchronous machine, dq0 Transformation and Park's transformation-
Computer representation for excitation and governor system – modeling of loads and induction machines.

UNIT-II: stability

Fundamental Concepts of Stability -Classification of Stability-
Steady state stability – steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus- time response – Stability by eign value approach.

UNIT-III:Simulation of Transient Stability

Equations of Motion: Swing Equation, calculation of inertia constant- Representation of loads – Alternate cycle solution method – Direct method of solution – Solution
Techniques: Modified Euler method – RungeKutta method – Concept of multi machine stability.

UNIT-IV: Excitation Systems

Excitation System Requirements, Elements of an Excitation System,
Types of Excitation System: Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system - Effect of excitation on power system stability

UNIT-V: Speed Governing systems

Block diagram of speed governing system- Effect of governor action on power system stability- Effect of saturation, saliency & automatic voltage regulators on stability.

Text Books

1. K R Padiyar, "Power System Dynamics Stability and Control", B S Publications
2. P.Kundur, "Power System Stability & Control", Tata Mcgraw hill
3. Vijay Vittal, Bergen , "Power Systems Analysis", Pearson Education

Reference Books

1. P C CrauseViley, "Electric machinery and Drive Systems", IEEE Press .
2. P.M Anderson and A.A Fouad, "Power System Control and Stability", Iowa State University Press, Ames, Iowa, 1978.
3. R. Ramanujam, "Power System Dynamics, Analysis and Simulation", PHI Learning, New Delhi, January 2010.

I M.TECH-II SEMESTER

Course Code : V18PST15

SOLAR & WIND ENERGY

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

SOLAR RESOURCES : Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types – Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators- Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers – Passive solar system - Active solar systems - Water desalination – Principle of solar ponds.

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UNIT-II

SOLAR PHOTOVOLTAICS: The Photo Voltaic effect- p-n junction-different types of photovoltaic cells- PV cell characteristics- Effect of variation of temperature, insolation level & tilt angle on the characteristics- equivalent circuits- temperature effects on conversion efficiency- Fabrication and costs of PV cell.

PV SYSTEMS : Photovoltaic modules- module specifications- bypass diodes-PV arrays and PV systems-cabling, earthing and lightning protection- Battery storage: Lead and Nickel cadmium batteries- Charge regulators-LVD circuit-Voltage and current Source Inverters. Tracking Systems-Maximum power point tracking.

UNIT-III

WIND ENERGY-I: Nature of wind – Characteristics – Variation with height and time – Power in wind – Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics– Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow.

UNIT-IV

WIND ENERGY-II: Siting – Rotor selection –Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies

UNIT-V

PV&WIND SYSTEM APPLICATIONS: Autonomous system; Grid Linked systems; Remote applications, System sizing; System Performance; Economics and future prospects.

Text Books

1. John Twidell and Tony Weir, “Renewable Energy Resources”, E &F.N.Spon
2. G.N.Tiwari and M.K.Ghosal, “Renewable Energy Resources Basic Principles and Applications”,Narosa

References Books

1. S.P.Sukhatme, “Solar Energy - Principles of thermal collection and storage”, TMH
2. Duffie& Beckman, “Solar Energy Thermal Processes”, Wiley
3. Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee , “Wind Energy Handbook”, Oxford

I M.TECH-II SEMESTER

Course Code : V18PST16

REAL TIME CONTROL OF POWER SYSTEMS

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

State Estimation. Operating states of power systems. Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data observability, Bad data detection, identification and elimination.

UNIT-II

Security and Contingency Evaluation-Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, and network sensitivity methods.

UNIT-III

Computer Control of Power Systems-Need for real time and computer control of power systems, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centres. Role of PMU in real time control.

UNIT-IV

Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V'curves and `Q-V' curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices and Research Areas.

UNIT-V

Application of AI and ANN in Power System: Basic concepts and definitions, algorithms for load flow, short term load forecasting, fault diagnosis and state estimation.

Text Books

1. Allen J. Wood and Bruce F. Wollenberg "Power Generation, Operation & Control" 2nd edition, John Wiley and Sons.
2. I.J. Nagarath& D. P. Kothari , "Modern power system analysis" 4th Edition, TMH

Reference Books

1. John J.Grainger and William D.Stevenson, Jr.,"Power System Analysis", McGraw-Hill, 1994, International Edition
3. R.N.Dhar,"Computer Aided Power Systems Operation and Analysis", Tata McGraw Hill, 1982
4. L.P.Singh,"Advanced Power System Analysis and Dynamics", Wiley Eastern Ltd. 1986
5. PrabhaKundur, "Power System Stability and Control", McGraw Hill, 1994
6. P.D.Wasserman, "Neural Computing : Theory and Practice", Van Nostrand - Feinhold, New York.

I M.TECH-II SEMESTER

Course Code: V18PST17

ELECTRIC AND HYBRID VEHICLES (ELECTIVE-III)

[L: 3; T: 0; P: 0 (3 credits)]

Unit-I:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization & transmission characteristics.

Unit-II:

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Unit-III:

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

Unit-IV:

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices

Unit-V:

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies.

Text Books:

1. Iqbal Hussein, "Electric and Hybrid Vehicles, Design Fundamentals", CRC Press, 2003.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.

Reference Books:

1. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electricand Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004.
2. SandeepDhameja, "Electric Vehicle Battery Systems", Newnes, 2000.

I M.TECH-II SEMESTER

Course Code: V18PST18

POWER SYSTEM DEREGULATION (ELECTIVE – III)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation ion deregulated environment and Indian Electricity act.

UNIT-II

Electricity sector structures and Ownership /management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

UNIT-III

FRAMEWORK and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices.

UNIT-IV

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing. Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

UNIT-V

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Text Books

1. S. Stoft, "Power System Economics: Designing markets for electricity"
2. J. Wood and B. F. Wollenberg, "Power generation, operation and control",
3. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, "Operation of restructured power systems"
4. LoiLeiLai, "Power system restructuring & Deregulation", Wiley publications.

Reference Books

1. M. Shahidehpour, H. Yamin and Z. Li, "Market operations in electric power systems- Forecasting, Scheduling, and Risk Management" , A JOHN WILEY & SONS, INC., PUBLICATION
2. S. Kirschen and G. Strbac, "Fundamentals of power system economics", Wiely publications

I M.TECH-II SEMESTER

Course Code : V18PST19

SMART GRID (ELECTIVE – III)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development& International policies on Smart Grid. Case study of Smart Grid.

UNIT-II

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT-III

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).

UNIT-IV

Microgrids and Distributed Energy Resources: Concept of micro grid, need & applications of micro grid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT-V

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”,CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,“Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, “Smart Grids”, Wiley Blackwell 19
5. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Futureof Electric Utilities”, Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 30 Jun 2009

7. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press

Reference Books:

1. Andres Carvallo, John Cooper, “The Advanced Smart Grid: Edge Power Driving Sustainability: 1”, Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson “Control and Automation of Electric Power Distribution Systems (Power Engineering)”, CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert “Substation Automation (Power Electronics and Power Systems)”, Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, “Electrical Power System Quality”, 2nd Edition, McGraw Hill Publication
5. Yang Xiao, “Communication and Networking in Smart Grids”, CRC Press

I M.TECH-II SEMESTER

Course Code : V18PST20

HIGH VOLTAGE ENGINEERING (ELECTIVE – III)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Generation of High AC & DC Voltages: Direct Voltages: AC to DC conversion methods electrostatic generators-Cascaded Voltage Multipliers.

Alternating Voltages: Testing transformers-Resonant circuits and their applications, Tesla coil.

UNIT-II

Generation of Impulse Voltages: Impulse voltage specifications-Impulse generations circuits-Operation, construction and design of Impulse generators-Generation of switching and long duration impulses.

Impulse Currents: Generation of High impulse currents and high current pulses.

UNIT-III

Measurement of High AC & DC Voltages: Measurement of High D.C. Voltages: Series resistance meters, voltage dividers and generating voltmeters.

Measurement of High A.C. Voltages: Series impedance meters electrostatic voltmeters potential transformers and CVTS-voltage dividers and their applications.

Measurement of Peak Voltages: Chubb-Fortesque methods.

Measurement of Impulse Voltages &Currents: Voltage dividers and impulse measuring systems Faraday generators

UNIT-IV

High Voltage Testing of Power Apparatus: Need for testing standards**–** Standards for porcelain/Glass insulators-Classification of porcelain/glass insulator tests **–** Tests for cap and pin porcelain/Glass insulators.

UNIT-V

High voltage AC testing methods-Power frequency tests-Over voltage tests on insulators, Isolators, Circuit Breakers and power cables

Impulse Testing: Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers.

Text Books

1. E.Kuffel and W.S.Zaengl., "High Voltage Engineering" PergamanPress Oxford, 1984.

2. M.S.Naidu and V.Kamaraju, "High Voltage Engineering"Mc.Graw-Hill Books Co., New Delhi, 2nd edition, 1995.

Reference Books

1. M.S.Naidu and V.Kamaraju, "High Voltage Engineering" Tata McGraw Hill Publishing Company Limited, New Delhi **–** 2001.

2. KREUGER, F.H., "Discharge Detection in H.V. Equipment", Haywood London **–** 1964.

I M.TECH-II SEMESTER

Course Code : V18PST21

CUSTOM POWER DEVICES (ELECTIVE – IV)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT- I

Introduction Custom Power and Custom Power Devices - power quality variations in distribution circuits –Voltage Sags, Swells, and Interruptions - System Faults – Over voltages and Under voltages - Voltage Flicker - Harmonic Distortion - Voltage Notching – Transient Disturbances - Characteristics of Voltage Sags.

UNIT-II

Overview of Custom Power Devices Reactive Power and Harmonic Compensation Devices Compensation Devices for Voltage Sags and Momentary Interruptions - Backup Energy Supply Devices – Battery UPS – Super Conducting Magnetic Energy Storage systems – Flywheel – Voltage Source Converter - Multi-level converters.

UNIT-III

Reactive Power and Harmonic Compensation Devices Var control devices - Static Var Compensator – Topologies - Direct Connected Static Var Compensation for Distribution Systems – Static Series Compensator - Static Shunt Compensator (DSTATCOM) – Interaction with Distribution Equipment and System - Installation Considerations.

UNIT- IV

High-Speed Source Transfer Switches, Solid State Limiting, And Breaking Devices: Source Transfer Switch - Static Source Transfer Switch (SSTS) - Hybrid source transfer switch – High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker.

UNIT-V

Application of Custom Power Devices in Power Systems P-Q theory – Control of P and Q – Dynamic Voltage Restorer (DVR) – Operation and control – Interline Power Flow Controller (IPFC) – Operation and control – Unified Power Quality Conditioner (UPQC) – Operation and control. Recent custom power devices.

Text Books

1. "Guidebook on Custom Power Devices, Technical Report", Published by EPRI, Nov 2000

2. Gerard Ledwich, ArindamGhosh, "Power Quality Enhancement Using Custom Power Devices– Power Electronics and Power Systems", Kluwer Academic Publishers, 2002.

Reference Books

1. C. Shankaran, "Power Quality", CRC Press, 2001.

2. H. Akagiet.al., "Instantaneous power theory and application to power conditioning", IEEE Press, 2007.

3. ArindamGhosh and Gerard Ledwich, "Custom Power Devices - An Introduction", Springer, 2002.

4. Yash Pal et.al.,, "A Review of Compensating Type Custom Power Devices for Power Quality Improvement", Joint International Conference on Power System Technology and IEEE Power India Conference, 2008.POWERCON 2008.

I M.TECH-II SEMESTER

Course Code : V18PST22

EHVAC TRANSMISSION (ELECTIVE – IV)

[L: 3; T: 0; P: 0 (3 credits)]

Unit-1: E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters - Bundle conductor systems inductance and capacitance of E.H.V. lines – positive, negative and zero sequence impedance.

Unit-2: Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines – effect high electrostatic field on biological organisms and human beings surface voltage gradients and maximum gradients of actual transmission lines

Unit-3: Electrostatic induction in unenergised lines – measurements of field and voltage gradients for three phase single and double circuit lines – unenegised lines. Power Frequency Voltage control and over voltages in EHV lines: No load voltage – charging currents at power frequency - voltage control

Unit 4: shunt and series compensation – static VAR compensation. Corona in E.H.V. lines – Corona loss formulae attention of traveling waves due to Corona – Audio noise due to Corona, its generation, characteristic and limits

Unit 5: Measurements of audio noise radio interference due to Corona RF properties of radio noise – frequency spectrum of RI fields. Design of EHV lines based on steady state and transient limits.

REFERENCES:

1. Rokosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", Wiley EASTERN LTD., NEW DELHI – 1987.

2. "EHV Transmission line reference Books", Edison Electric Institution (GEC 1968).

Text Books:

1. Sanjay Sharma,"EHVAC, HVDC Transmission and distribution engineering", KHANNA PUBLISHERS
2. Schobhitgupta and Deepak Gupta, "EHV AC/DC Transmission", Genius Publications

I M.TECH-II SEMESTER

Course Code : V18PST23

DEMAND SIDE ENERGY MANAGEMENT (ELECTIVE – IV)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I

Energy Audit and Energy management information systems: Energy audit: Definitions-Need-concepts-Types of energy audit;

Energy Economics: Introduction-Cost benefit risk analysis-Payback period-Straight line depreciation-Sinking fund depreciation—Reducing balance depreciation-Net present value method-Internal rate of return method.

UNIT-II

Energy Conservation in Electric utilities and Industry: Electrical load management: Energy and load management devices-Conservation strategies; conservation in electric utilities and industry: Introduction- Energy conservation in utilities by improving load factor-Utility voltage regulation-Energy conservation in Industries.

UNIT-III

Energy –ef icient electric motors: Energy efficient motors-construction and technical features-performance characteristics; Economics of EEMs and system: life cycle-direct savings and payback analysis-efficiency factor.

UNIT-IV

Electric Lighting: Introduction-Need for an energy management program-Building analysis-Modification of existing systems- Replacement of existing systems-priorities

Illumination requirement: Task lighting requirements-lighting levels system modifications-non illumination modifications-lighting for non-task areas-reflectance-space geometry; System elements: light sources - characteristics of families of lamps-lamp substitution in an existing systems-selection of Higher efficiency lamps for a new system- Luminaries-ballasts-energy conservation in lighting.

UNIT-V

Space Heating, Ventilation, Air-Conditioning (HVAC) and Water Heating: Introduction-Heating of buildings-Transfer of Heat-Space heating methods-Ventilation and air-conditioning-Insulation-Cooling load- Electric water heating systems-Energy conservation methods.

Co-generation and storage: Combined cycle cogeneration-energy storage: pumped hydro schemes-compressed air energy storage (CAES)-storage batteries-superconducting magnetic energy storage (SMES)

Text Books

1. Wayne C.Turner, “Energy management Hand book”,,John Wiley and sons publications
2. S C Tripathy, “Electric Energy Utilization and Conservation”, Tata McGraw hill publishing company ltd. New Delhi
3. John C.Andreas, “Energy efficient electric motors selection and application”.

Reference Books

1. Amit Kumar Tyagi, “Hand book on Energy Audit and Management”, TERI (Tata energy research Institute)
2. Paul W.O’ Callaghan, “Energy management”, McGraw hill book company
3. Rakosh Das Begamudre, “Energy conversion systems”, New age international publishers

I M.TECH-II SEMESTER

Course Code : V18PST22

H.V.D.C AND FACTS (ELECTIVE – IV)

[L: 3; T: 0; P: 0 (3 credits)]

UNIT-I:H.V.DC Transmission: General consideration, Power Handling Capabilities of HVDC lines, static converter configuration. Static Power Converters: 3 pulse, 6 pulse & 12 pulse converters, converter station and terminal equipment communication process, Rectifier and inverter operation

UNIT-II: Control of HVDC converter and systems: constant current, constant extinction angle and constant ignition angle control. Individual phase control and equidistant firing angle control. Harmonics in HVDC systems, Characteristic and uncharacteristic harmonics-troubles due to harmonics-harmonic filters.

UNIT-III: Converter faults and protection in HVDC systems: Converter faults, over current protection- valve group and DC line protection. Over voltage protection of converters.

UNIT-IV: FACTS concepts, importance of controllable parameters, basic types of FACTS controllers**,** Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, methods of controllable var generation, variable impedance type static var generators, switching converter type var generators.

UNIT-V: Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

Text Books

1. E.W.Kimbark,"Direct current Transmission", Wiely inter Science- New york.
2. J.Arillaga,"H.V.D.C.Tranmission", peter peregrilnus ltd., London UK 1983
3. N.G.Hingorani and L.Guygi, "Understanding FACTS Devices", IEEE Press. Indian Edition is available:— Standard Publications

References Books

1. "EHV Transmission line reference Books", Edison Electric Institution (GEC 1968).
2. K.R.Padiyar,"High Voltage Direct current Transmission", Wiely Eastern Ltd
3. E.Uhlman,"Power Transmission by Direct Current", Springer Verlag, Berlin
4. Sang.Y.H and John.A.T, "Flexible AC Transmission systems", IEEE Press (2006).
5. Vijay K.Sood, "HVDC & FACTS Controllers: applications of static converters in power systems", Springer publishers

I M.TECH-II SEMESTER

Course Code : V18PSL02

POWER SYSTEMS LAB-II

[L: 0; T: 0; P: 4 (2 credits)]

Any 10 of the following experiments are to be conducted

1. Determination of Sequence Impedance of an Alternator by direct method.
2. Determination of break down strength of Transformer oil Testing.
3. Measurement of sequence impedance of a three phase transformer by application of sequence voltage.
4. Power angle characteristics of a salient pole Synchronous Machine.
5. Scott connection of transformer.
6. Determination of equivalent circuit of 3-winding Transformer.
7. Measurement of ABCD parameters on transmission line model.
8. Optimal power flow.
9. Reactive power compensation Br minimization of power loss using PSO
10. State estimation of power systems.